

National Aeronautics and
Space Administration



John F. Kennedy Space Center

SPACEPORT
ENGINEERING AND
TECHNOLOGY

Maximum Frictional Charge Generation on Polymer Surfaces

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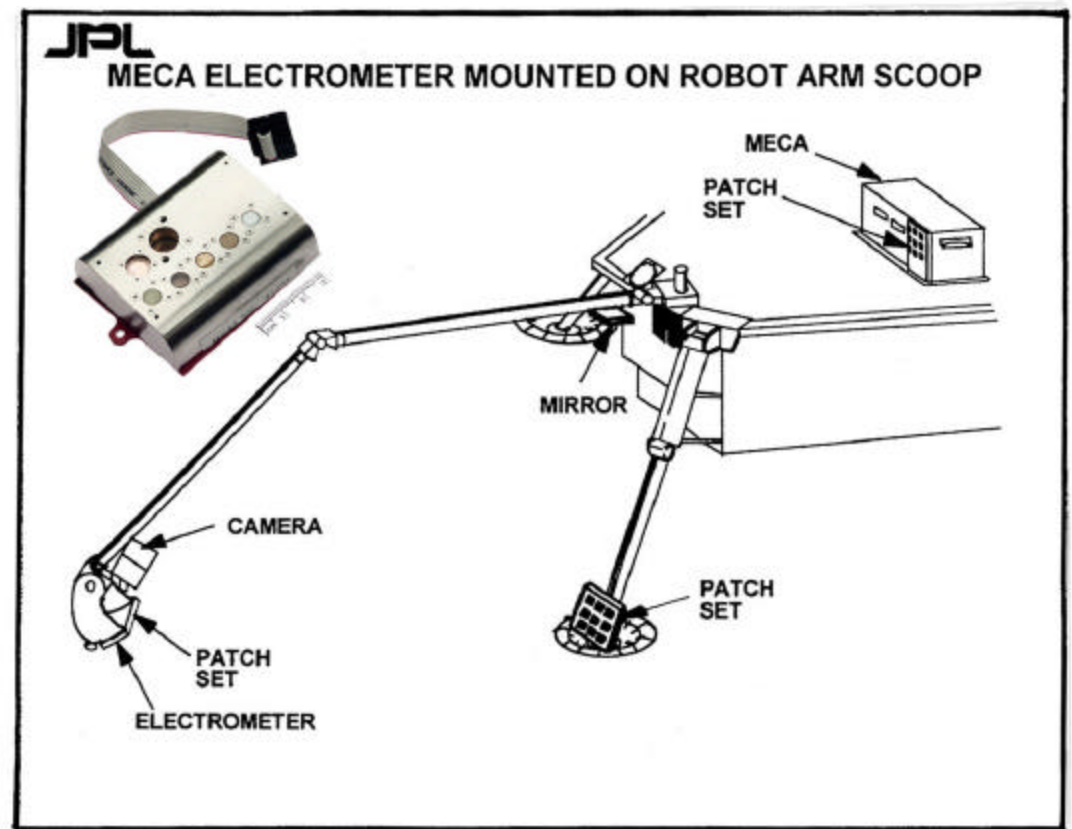
Introduction

- Maximum charge deposited on a surface is limited by:
 - Atmospheric composition
 - Atmospheric pressure
 - Temperature
 - Humidity
- Final charge is limited by electrical breakdown (Paschen curves)
- Experiments with the MECA Electrometer were performed
- 5 polymer surfaces were rubbed with wool at different pressures until charge saturation was achieved



MECA Electrometer

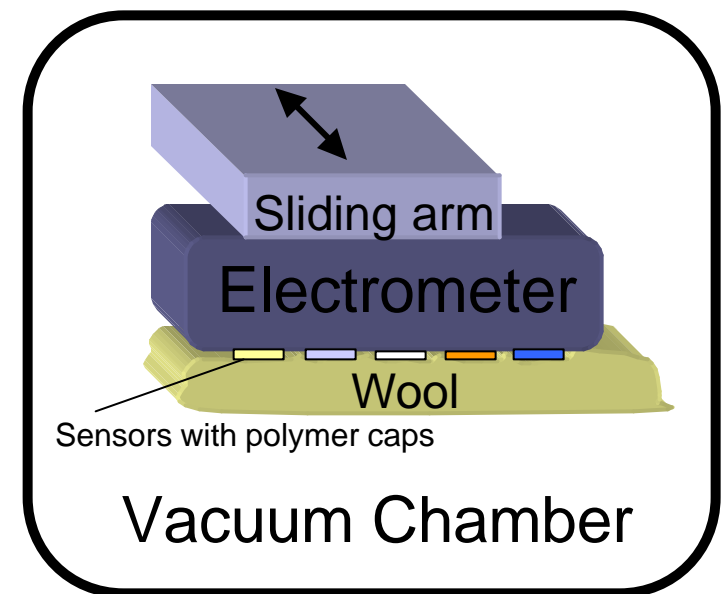
- Multisensor Electrometer developed for Mars Lander
- 5 electrometers with:
 - Fiberglass/Epoxy, G-10
 - Polycarbonate (Lexan)
 - PTFE (Teflon)
 - Rulon J
 - PMMA (Lucite)
- In addition:
 - Bare electrometer
 - Ion gauge
 - Thermometer





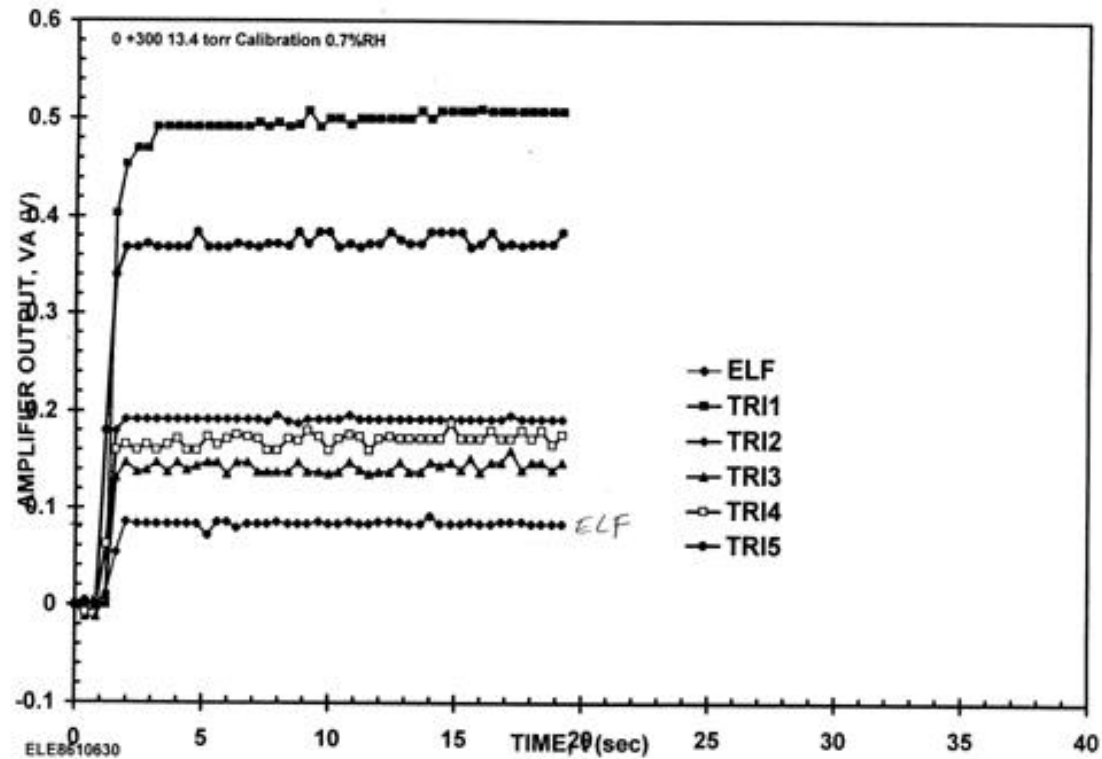
Experiments

- The MECA Electrometer, mounted on a sliding arm, was brought into intimate contact with wool
- Repeated rubbings inside a vacuum chamber were made at 1-700 torr and $RH < 5\%$
- Sliding contact was maintained until charge saturation was observed
- A corona ionizer was used to neutralize polymers after each run





Electrometer Response

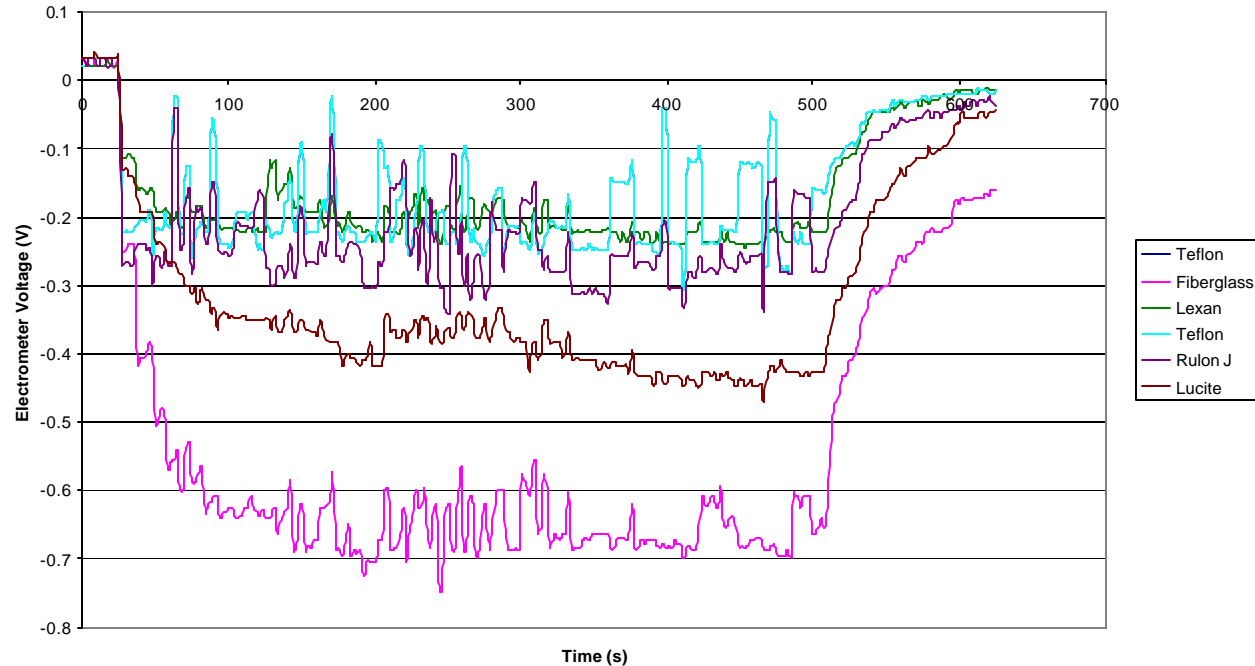


Sensor amplifier output with 300 V input voltage



Rubbing Structure

Rubbing Structure - 10 torr

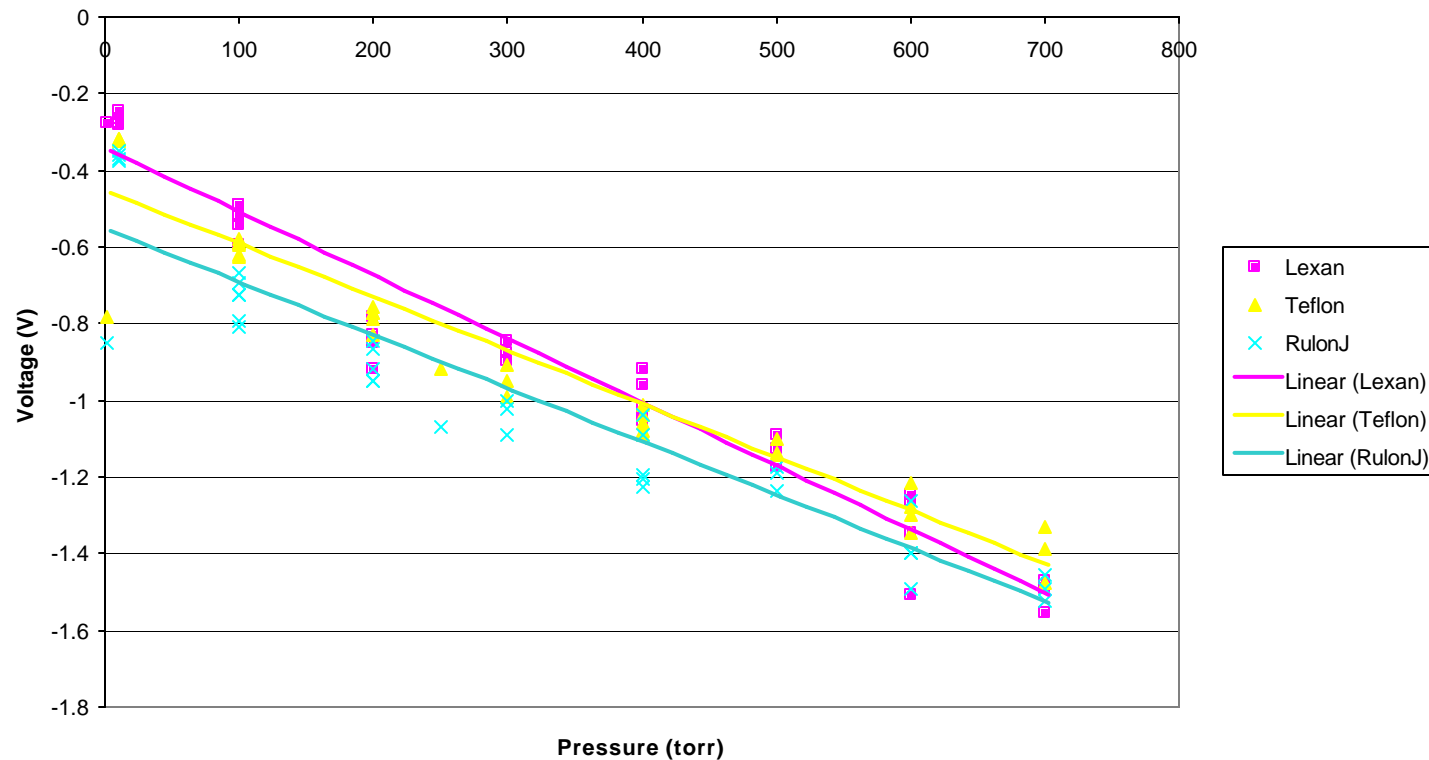


- Vigorous repeated rubbing with wool at 10 torr and $RH < 2.5\%$
- Sensor sensitivity = 0.25 nC/V

Lexan, Teflon, Rulon J



Maximum Voltages on PTFT, Rulon J, and Lexan

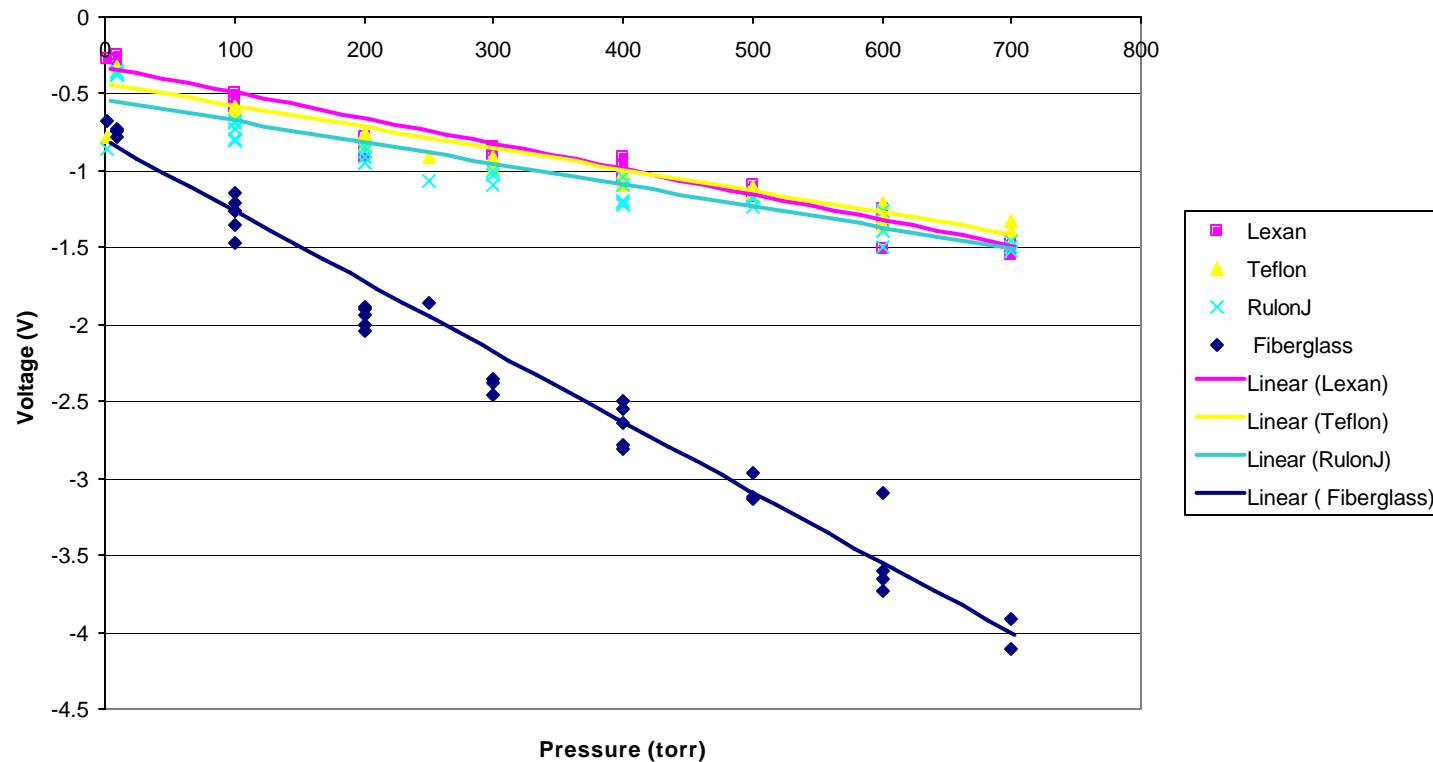


- Vigorous rubbing with wool at $RH < 5\%$ and $1.37 \text{ torr} < p < 700 \text{ torr}$

Lexan, PTFT, Rulon J, G-10



Maximum Voltages on PTFT, Rulon J, Lexan, and Fiberglass

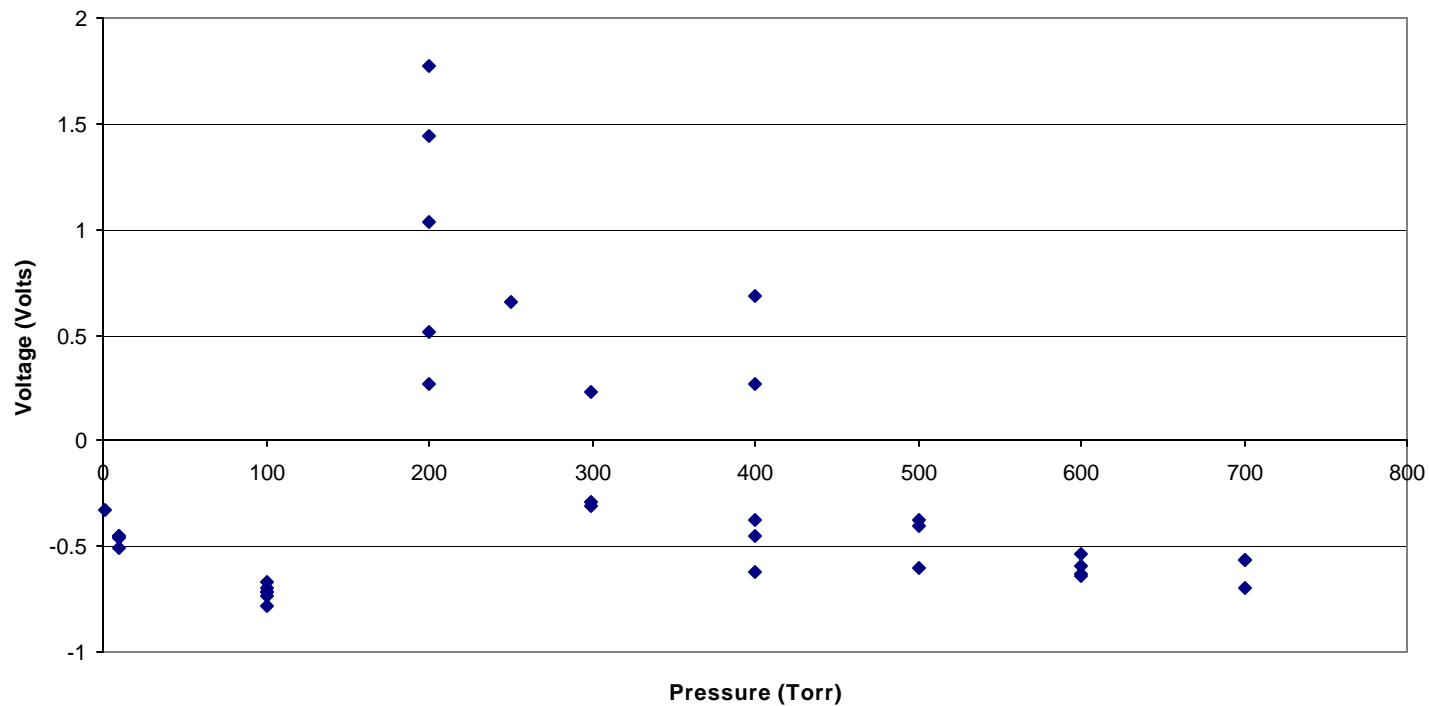


- Vigorous rubbing with wool at $RH < 5\%$ and $1.37 \text{ torr} < p < 700 \text{ torr}$

PMMA



Pressure vs. Maximum voltage
Data From 12-1 to 12-5-2000; Rubbing with Wool until Max is reached
Lucite



- Vigorous rubbing with wool at $RH < 5\%$ and $1.37 \text{ torr} < p < 700 \text{ torr}$



Polymer Water Absorption Rates

POLYMER	RATE @ 24 h
• Fiberglass/Epoxy, G-10	~ 0
• Polycarbonate (Lexan)	0.16%
• PTFE (Teflon)	0.01%
• Rulon J	0%
• PMMA (Lucite)	0.3%



Conclusions

- Five insulators (G-10, Polycarbonate, PTFE, Rulon J, and PMMA) were vigorously rubbed (repeated contact and separation) with wool at 1.37 to 700 torr and $RH < 5\%$
- At each pass, voltages are seen to increase to a maximum value and rapidly discharge.
- Subsequent passes produce more charge until saturation is observed.
- Discharge may be surface flashover to surrounded grounded case
- Only surface states are believed to be populated.
- Maximum voltages achieved appear to follow Paschen discharge values.
- PMMA data is unreliable. Water absorption rate = 0.3% might explain behavior.